

## FINAL PROGRESS REPORT

**Project Title:** Development of an Alpha/Beta/Gamma Phoswich-Based Radiation Detector for Nuclear Waste Stream Cleanup Processes

**Covering Period:** June 1, 2001 to December 31, 2003

**Date of Report:** March 9, 2004

**Recipient:** University of Missouri-Columbia

**Award Number:** DE-FG07-01ID14118

**Subcontractors:** None

**Other Partners:** None

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**Project Team:** Tushar Ghosh, Co-PI

**Project Objective:** **Overall Project Goal –**  
  
The goal of this research is to design, build and test a phoswich-based radiation detector for simultaneously monitoring all radioactive components in the effluent resulting from the cleanup of nuclear waste.

**Background:** At numerous DOE sites around the nation, facilities are being developed to process wastes that are in storage from past nuclear activities. Through the proposed treatment processes, potential environmental threats can be mitigated and nuclear materials can be concentrated for ultimate disposal. Accurate monitoring of the radioactivity in the waste processing streams must be carefully quantified to insure that radioactivity in effluents are below prescribed levels. To address this need, an innovative, alpha/beta/gamma/neutron radiation detection system is to be developed for this radiological engineering application. Simultaneous measurements of all radioactive components can be performed at very low levels through active, electronic discrimination of

different types of radiation. This system incorporates new digital signal processor (DSP) techniques using a flash analog-to-digital converter (FADC) system for radiation detector pulse analysis. Specifically, it couples digital technology to phoswich detectors to provide more accurate and reliable particle discrimination and spectroscopy. The research proposed here will allow implementation of this useful technology to nuclear waste handling processes.

**Status:**

A complete analysis of the proposed detector system has been completed using the MCNP Monte Carlo code (1,2, 3). Based upon this analysis, the specifications for a new detector have been completed. These were submitted to Rexon and Bicron for bids in early 2003. However, due to delays in getting responses from these companies, a no-cost time extension until December 31, 2003 was requested and received. In the meantime, the software system for acquiring the data from the new detector was upgraded to Visual Basic. The detector was delivered in the fall 2003 and has undergone preliminary testing. The detector responds as expected to all three types of radiation, i.e. gamma, beta and alpha. Pulse shape discrimination between gamma-ray events and alpha events have also been achieved with the new detector and software. However, discrimination between beta and gamma events has not been demonstrated and modifications to the pulse shaping circuitry are underway. Until this is accomplished, final performance parameters can not be established. Although the DOE contract has expired, research on this system is continuing with one graduate student and one undergraduate student committed to the project. It is envisioned that a revised final report will be submitted when final performance parameters have been measured.

1) Childress, N. and W. H. Miller, "MCNP Analysis of a Phoswich Detector," Trans. Am. Nucl. Soc., **86**, 229 (June 10-13, 2002).

2) Childress, N. L. and W. H. Miller, "MCNP Analysis and Optimization of a Triple Crystal Phoswich Detector," Nuclear Instruments and Methods, Section A, **490**(1-2), 263-270 (Sept 1, 2002).

3) Miller, W. H. and M. Diaz de Leon, "Utilization of Phoswich Detectors for Simultaneous, Multiple Radiation Detection," Journal Radioanalytical Chemistry (accepted).

**Plans for Next Year:** Although the DOE contract has expired, research on this system is continuing with one graduate student and one undergraduate student

committed to the project. It is envisioned that a revised final report will be submitted when final performance parameters have been achieved.

**Patents:** None

**Milestone Status Table:**

ID Number	Task / Milestone Description	Planned Completion	Actual Completion	Comments
1	Phase I			
1.1	Literature Review	4/31/02	4/31/02	
1.2	Detector Preliminary Design	4/31/02	4/31/02	
1.3	Estimated Performance	4/31/02	9/1/02	
2.	Phase II			
2.1	Additional Modeling	12/31/02	12/31/02	
2.2	Final Design	12/31/02	12/31/02	
2.3	Detector Fabrication	2/31/03	9/1/03	Difficulty getting bids from manufacturers
2.4	Testing	5/1/03	12/31/03	
2.5	Final Report	5/1/03	12/31/03	

**Budget Data:**

(Budget data will be provided via the Sponsored Programs Office of the University of Missouri-Columbia)